GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: March 3, 1980

Project Title: Proposal for Investigation of Frame Design Improvements

Project No: A-2576

Project Director: R. A. Moore

Sponsor: Pioneer Heddle and Reed Co., Inc.; Atlanta, Ga.

Agreement Period: From February 5, 1980 Until ~~March 5, 1980~~ 8/31/81

Type Agreement: Standard Industrial Agreement

Amount: $5,679

Reports Required: Final Engineering Report

Sponsor Contact Person (s):

Technical Matters

Contractual Matters
(thru OCA)

Mr. Robert N. Suhr, President
Pioneer Heddle & Reed Co., Inc.
1373 Murphy Avenue, S. W.
Atlanta, Ga. 30310

Defense Priority Rating: None

Assigned to: STL/SDD (School/Laboratory)

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GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 9/16/81

Project Title: Proposal for Investigation of Frame Design Improvements

Project No: A-2576

Project Director: R. A. Moore

Sponsor: Pioneer Heddle and Reed Co., Inc.; Atlanta, Ga.

Effective Termination Date: 8/31/81

Clearance of Accounting Charges: 8/31/81

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice ~~and Closing Documents~~
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other ______

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INTERIM TECHNICAL REPORT

Investigation of Frame Design Improvements
EES/GIT Project A-2576

By

Jeffrey A. Madill

Prepared for

Pioneer Heddle and Reed Co., Inc.
P. O. Box 10586
Atlanta, Georgia 30310

November 1980

INVESTIGATION OF FRAME OPERATION PARAMETERS

Maruyama frames have been instrumented in operating conditions by researchers of the Georgia Institute of Technology, Engineering Experiment Station. Measurements have been made utilizing High Speed Photography and strain gauge bridges. The latter have yielded the most information about the environment that a frame is subjected to when weaving at high speed. Additional measurements of frame resonances were performed utilizing a spectrum analyzer in an effort to correlate measured strain frequencies with natural resonant modes of the frame. The latter measurements revealed a horizontal resonance of 5.25 Hz (which is the same as the vertical weaving frequency). Resonances were also noticed that might correspond with indicated strain frequencies.

The strain measurements in Figures 2 thru 5 represent two basic cases with enough differences to make correlation difficult. The two frames accessable for strain gauge application were operating at different rates (one up, one down vs two up, two down) and with differing loads (virtually no ends vs approximately 1,000 ends). Nonetheless, it is apparent that the frames see stresses almost as great as the fundamental weaving stress but at frequencies up to ten times the fundamental weaving frequency.

The timing mark at the top edge of Figures 2 thru 5 indicate when the front frame is down (weaving one up, one down). The timing mark at the bottom of Figures 2 thru 5 indicate one-second intervals.

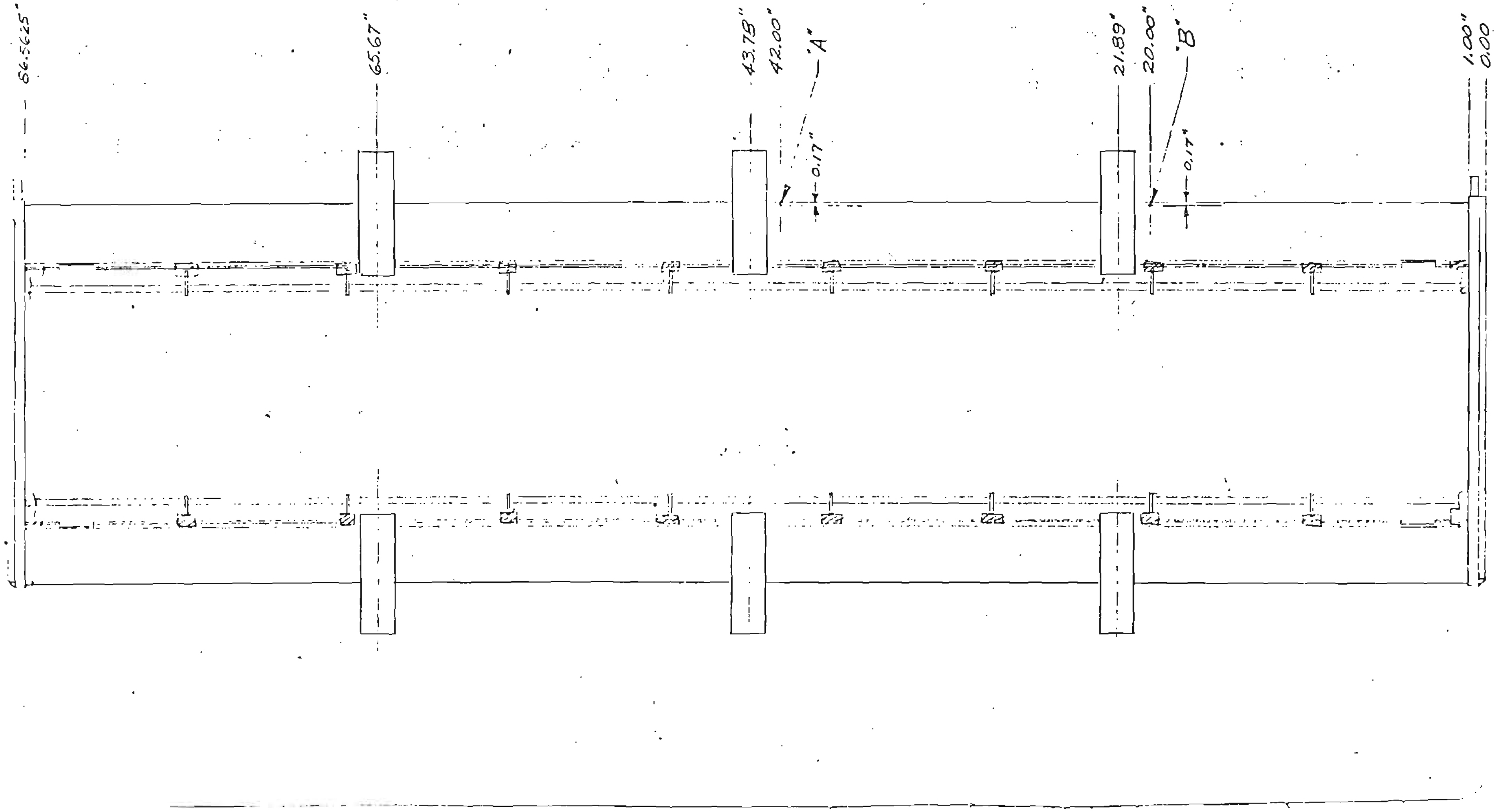

FIGURE 1. Drawing of Maruyama Frame
Strain Gauge Pairs at A & B

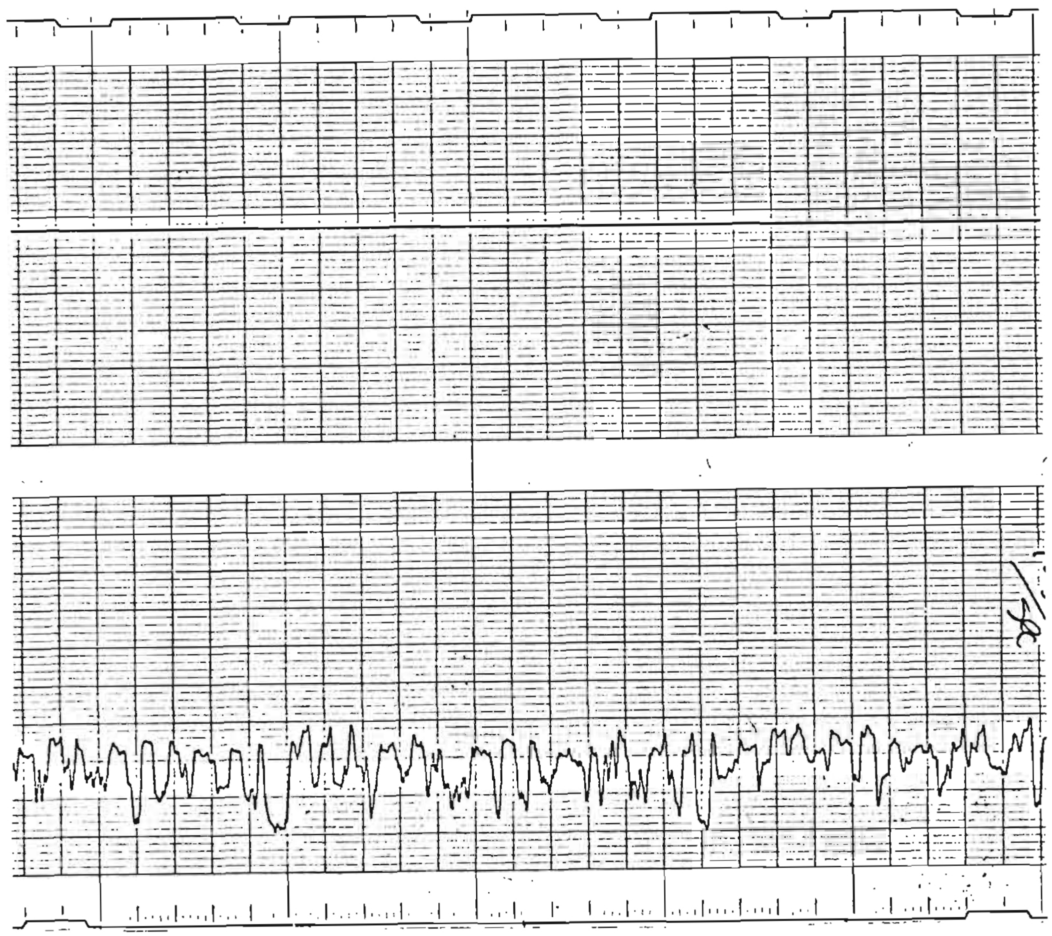

FIGURE 2. Strain at A resulting from bending forward and back.

630 picks per minute
2 up, 2 down
Approximately 1,000 ends
3.78 min./in. per division, 37.8 psi/division

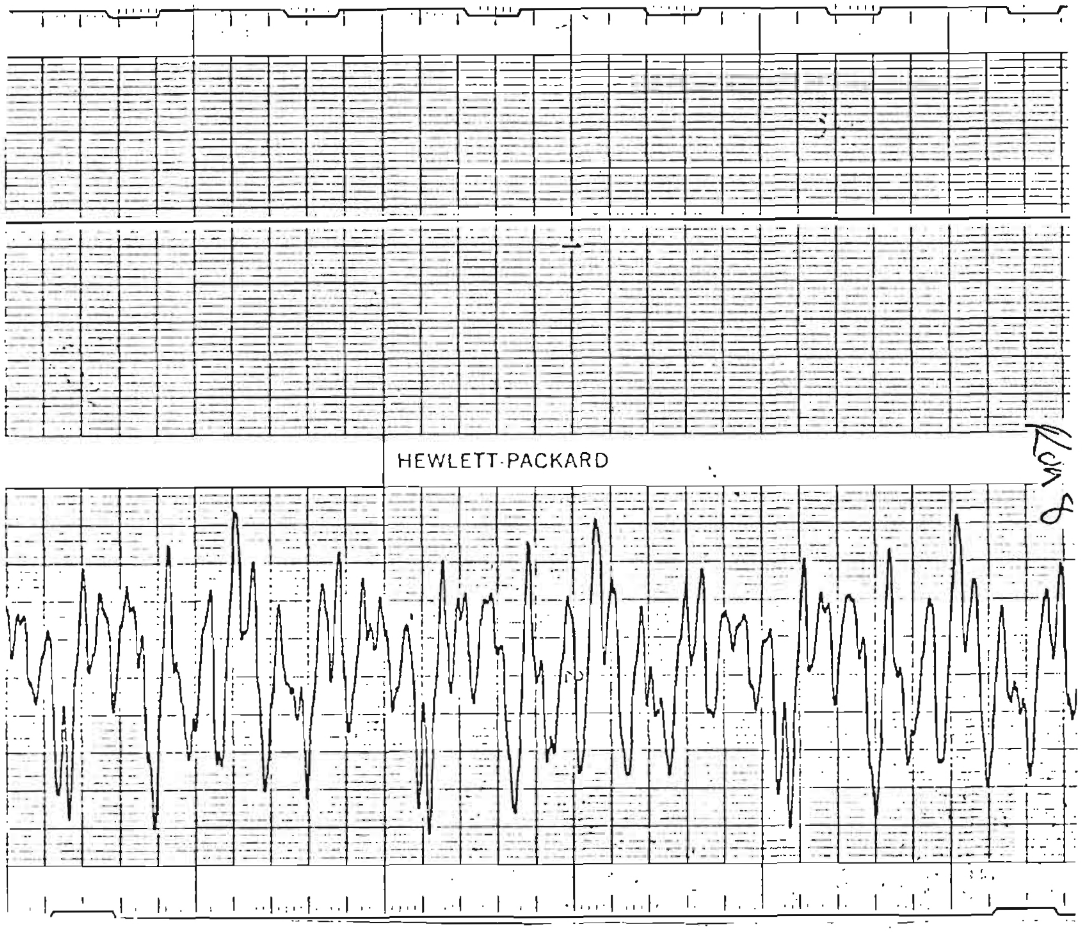

FIGURE 3. Strain at A resulting from bending up and down.

630 picks per minute
2 up, 2 down
Approximately 1,000 ends
7.56 min./in. per division, 75.6 psi/division

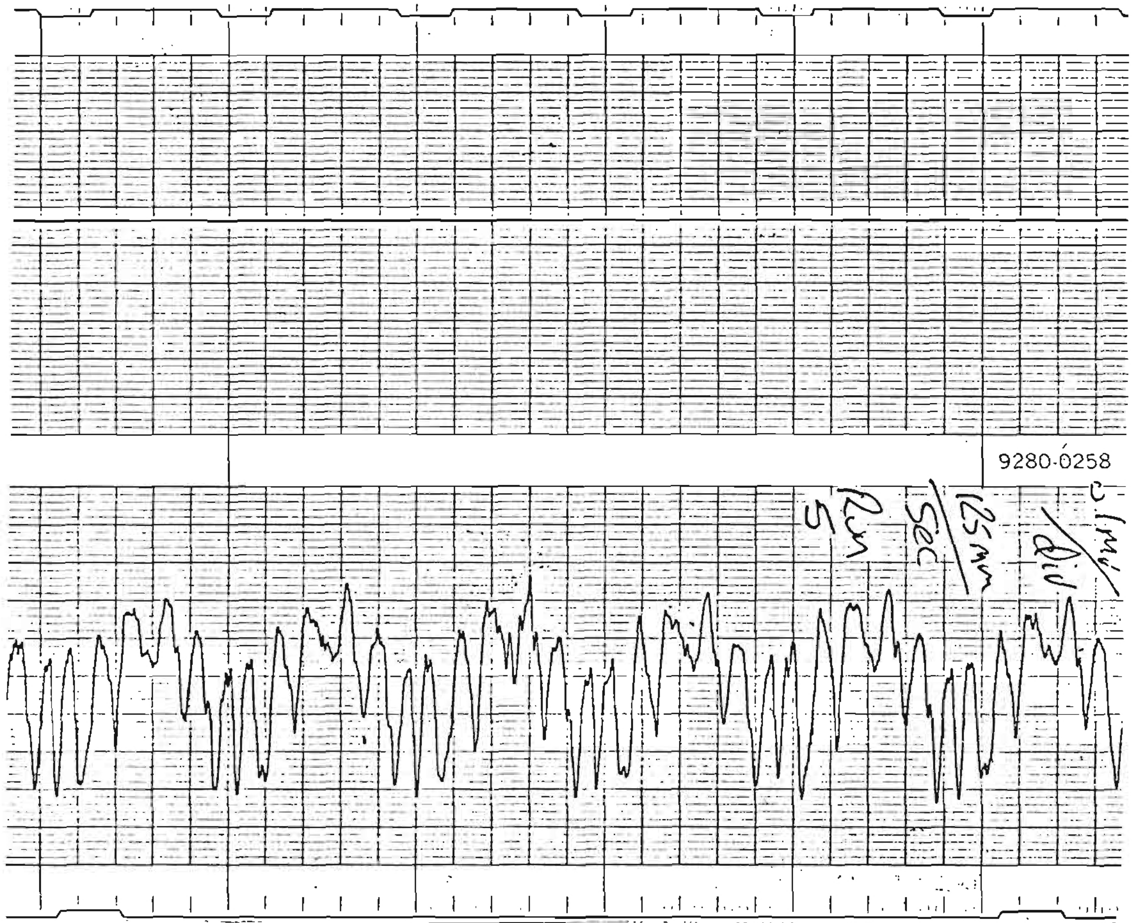

FIGURE 4. Strain at B resulting from bending up and down.

630 picks per minute
1 up, 1 down
Approximately 2 ends
3.78 min./in. per division, 37.8 psi/division

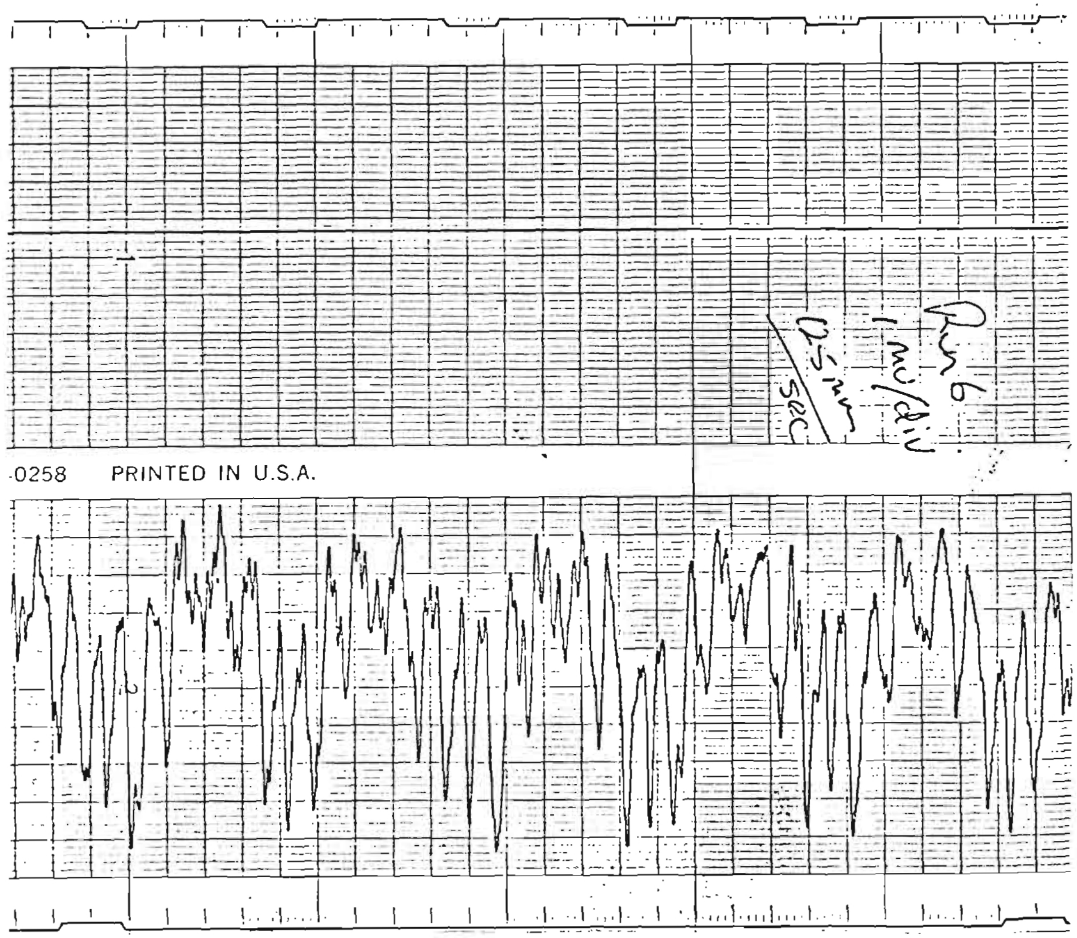

FIGURE 5. Strain at A resulting from bending up and down.

630 picks per minute
1 up, 1 down
Approximately 2 ends
3.78 min./in. per division

A-2576

FINAL TECHNICAL REPORT

Investigation of Frame Design Improvements

EES/GIT Project A-2576

by

Jeffrey A. Madill

Prepared for

Pioneer Heddle and Reed Company, Inc.
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August 1981

INTRODUCTION

The Engineering Experiment Station, Systems and Techniques Laboratory entered into an Industrial Agreement Type of contract with the Pioneer Heddle and Reed Company, Incorporated to perform measurements and analysis of various types of frames utilized on weaving looms. This program was assigned the EES Project Number, A-2576.

This Final Technical Report has been prepared and indicates the sequence used in measuring data on three (3) frames of different manufacturers, a Pioneer Heddle and Reed frame, a Steel Heddle frame, and a Grob frame.

The measured data collected is representative of these three different frames in twenty different operating conditions. Six different measurements were made for each operating condition considered to provide quantitative information about the operating environment in which a frame must survive. Frames were run in Slots 1 and 4 of Pioneer's loom simulation machine to avoid frame to frame contact and thus provide the most repeatable testing conditions possible.

The twenty operating conditions consist of variation of position (one of two operating slots), variation of heddle load (all or none), and variation of speed (200, 300, 400, 500, 600 picks per minute). To reduce the amount of data to a manageable level, not all conditions were varied for all frames. The following table will illustrate the conditions under which the speed was varied:

	Slot 1	Slot 4
Grob Frame, all heddles	1	No
Steel Heddle Frame, all heddles	4	2
Pioneer Frame, all heddles	No	3
Grob Frame, no heddles	No	No
Steel Heddle Frame, no heddles	5	No
Pioneer Frame, no heddles	No	6

The numbers indicate the order in which the data are presented in the notebooks and the numbers are repeated there for reference purposes. Note that most direct comparison can be made between the Steel Heddle frame and the Pioneer frame which have been measured with heddles in the same slot.

DATA ORGANIZATION

The data are organized in lab notebooks to facilitate storage, comparison, and interpretation. Two books were used because one was insufficient for all the data. There is a page to page correspondence between the two books however, and the data on a particular page number represent one particular measurement at one particular speed for the six numbered conditions. The following is a summary of the page numbers and a description of the measurements presented:

Pages 7 - 19	Right and left end accelerations
Pages 21 - 33	Left end acceleration and up/down bending of shafts
Pages 35 - 47	Left end acceleration and left to right bending of left end
Pages 49 - 61	Left end acceleration and front to back bending of shaft
Pages 63 - 75	Left end acceleration and front to back bending of left end

STRIP CHART RECORDER

All data were recorded by a Hewlett Packard Model 7402A two channel chart recorder. The Model 17401A Medium Gain Preamps have selectable gains which correspond to pen deflection. Most acceleration measurements utilized a gain of 20 millivolts per division and most strain measurements utilized a gain of one millivolt per division. When the signals get too large, the gain is reduced at the chart recorder. The frequency response of the chart recorder extends to 150 Hz which is about 30 times the operating frequency of 600 ppm (5 Hz).

ACCELERATION MEASUREMENTS

Acceleration data were taken utilizing accelerometers manufactured by Consolidated Electrodynamics (CEC) type 4-280-0002. These units have an output sensitivity of 24 mv/G nominally and 19 mv/G minimal. This output is recorded directly by the chart recorder and the two chart recorder gains that were used were 20 mv/div and 50 mv/div. Full scale deflections at these gains indicate accelerations of 20.8 Gs and 52 Gs, respectively. Observation of these signals with an oscilloscope indicated that some of the higher frequency components are around 50% larger in magnitude. Such higher frequency components can be observed by simply tapping on the frame at rest and seem to be more closely associated with noise rather than any significant motion. Two accelerometers were used to measure the acceleration of the two end pieces.

STRAIN MEASUREMENTS

Strain measurements were accomplished using two pairs of strain gages. The gage used is manufactured by Micro Measurements and is type CEA-013-25UW-350. This gage has a quarter inch long grid, is temperature compensated for aluminum, and is encapsulated with a protective coating to protect the grid from contamination.

The strain gages are mounted in pairs, one on the front of the frame and one directly behind. Two strain gage pairs are used to provide the four different strain measurements presented. Each pair is symmetric about the front to back bending axis although only approximately so for the end piece which is assymmetric. When the shaft or end bends toward the front, the front gage stretches and resistance becomes lower. This opposite and equal response is isolated in all the data marked bending.

Each pair is also displaced from the neutral axis when bending is in the plane of the motion of the frame. Although the shaft is bending up and down and the end pieces are bending out and in, the strain gages are being equally stretched and compressed respectively. The measurement configuration of the gages which cancels the bending described previously is referred to as the stretching configuration on the data.

The strain gages are measured using a BLH Model 1200B Digital Strain Indicator which is not the best instrument for making dynamic measurements. A special, full bridge and switching circuit was constructed to interface with the desired measurement schemes and the indicated strain is thus exactly twice the actual strain (due to the extra sensitivity of the special bridge configurations). An indicated strain of 240 micro inches per inch provides a dynamic output signal of 24 millivolts so we have a recording constant of five micro inches per inch per millivolt. The most common chart recorder gain was one millivolt per division but 2 mv/div and 5 mv/div were used in some cases.

STRAIN GAGE LOCATION

The strain gage pairs have been consistently located as close to the edge of the mounting surface as possible. The radius of the edge makes this location approximately 5/32 of an inch from the edge to assure a flat surface under all the gages. The Grob shaft requires a gage location of 5/16 of an inch from the edge due to the bevel of the extrusion. Calculation of the neutral axis of these composite and assymmetric beams has not been done so the stress level is not known but should be comparible to that of the Maruyama frames tested earlier in the project.

Shaft gages are located at the center of the shaft and end piece gages are located at the heddle loading hole. The latter location is 9 5/8 inches from the bottom of the Grob and 9 7/8 inches from the bottom of the Steel Heddle and Pioneer shafts.

OBSERVATIONS AND RESULTS

The most striking observation is the complexity of the acceleration of the end pieces. The fundamental shedding motion is almost totally obscured by reactions to the resonances of the frames and is far too complex to model economically.

The next observation is the similarity of response of the three different frames. The Pioneer frame and the Steel Heddle frame when tested in the same slot show almost equal response (conditions 3 and 2, respectively). The Steel Heddle frame operating in two different slots shows some difference (conditions 2 and 4) but comparison with the Steel Heddle frame in Slot 1 and the Grob frame in Slot 1 (conditions 5 and 1) again shows much similarity.

The end piece measurements show more differences but these are more strongly dependent on the alignment of the slots and pulling mechanisms. The end guides had to be moved between conditions 1, 2, and 3 and conditions 4, 5, and 6 so comparison between same slot cases may have alignment variations included.

Operation without heddles increases the resonant frequency of the frame system. Although the magnitude of strain is much smaller, the frequency of strain reversals is approximately three times higher.

RECOMMENDATIONS

Major conceptual changes in frame structure and frame-dobby-support system may yield far more observable results with this type of instrumentation. The difference in the method of rigid attachment between shaft and end between the Grob, Steel Heddle, and Pioneer models tested seems to make little difference in the measurements we made.

Static testing with a material such as stress coat would probably yield more useful information concerning the stresses local to that attachment point. Major conceptual changes which allow more damping and stiffness would be better tested by the methods we have been asked to employ here. Presently, we have a procedure and data corresponding to stresses in current designs under simulated operating conditions. New concepts can now be compared.